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SUMMARY REPORT NO. 2

AIRSICKNESS IN MILITARY AVIATION

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Summary reports reviewing the more significant findings contained in reports from service and civilian laboratories in the United States and Allied Countries are issued from time to time. It is the purpose of these summaries to make available to flight surgeons and research personnel a brief survey of the information relating to a certain subject contained in the numerous and often voluminous reports in the files of the Air Surgeon. There is no assurance that the files are complete in every detail but it may be assumed that the summaries will fairly indicate the trend of work and opinions in the field. The information here reported is a review of the available reports and does not necessarily reflect the opinion of the Air Surgeon or his staff.

Airsickness is a form of motion sickness that afflicts some men when they fly. A survey made at a Navigator School (13) in the United States showed that eight out of each class of 130 are eliminated because of airsickness and approximately one-third of candidates are airsick at least once. This is not a general rule for air crews. In a group of 647 air gunners only six were eliminated because of persistently recurring airsickness. One Canadian survey of air corp cadets showed that four percent of trainees were sick on more than one occasion and about 0.5 percent ceased training because of airsickness (1). In a further report figures as high as 6.5 per-cent were given as the incidence of ceased-training cases caused by airsickness (2). One survey rates airsickness third highest as a cause of washouts among student pilots (3) (See also 25). It was further estimated that four flying hours were lost in the training program following each attack. In England about 10 - 15 percent of trainees are airsick during the first six hours of flight after which most of them adapt to the motion (4). This adaptation is, however, not for all forms of motion because experienced aviators are frequently airsick during their first glider flight (5),

The principal symptoms of airsickness are pallor, cold sweating, nausea and vomiting. These effects are thought to arise from disturbance of the sense of orientation in space caused by conflicting signals from the eye and internal ear (26). Whatever be the mechanism it seems that an unusual degree of stimulation of the organs of the internal ear is an essential step in production of airsickness. Motion of the aircraft causing rotation of the head in the planes of the vertical semicircular canals and vertical accelerations (bumping) which stimulate the utricular organ are reported to be the most unpleasant forms of motion (26). The sensations arising from these motions are thought to be associated with the primitive fear of falling. Visual impressions giving a strong sense of orientation sometimes serve to suppress the sick feeling except in the most susceptible subjects.

A severe attack leaves a man weak and ineffective for some hours. Consequently, a repeatedly airsick person is unsuited for assignment to flying training. It has been recommended that men persistently sick after 10 - 20 hours of flying should cease flying (26). If an accurate test of susceptibility to airsickness were available, the repeatedly airsick men could be eliminated without waste of time and personnel in useless training. Some method of testing is especially important for paratroops and glider-borne troops because such men do not always have sufficient flying time during training to establish their susceptibility to airsickness. Therefore, an important problem in aviation medicine is to develop a test that will measure man's susceptibility to airsickness and his ability to adapt to the unusual motions.

The most direct attack on this problem of classification is to find some controlled form of motion that produces similar symptoms by the same physiological mechanism. It is known that the symptoms of swing sickness are similar to those of other forms of motion sickness (6). To determine whether these symptoms are produced by the same mechanism involved in airsickness, the following studies were made.

Subjects were swung for twenty minutes through an arc of 120° while lying supine on the swinging platform (6). They were thus subjected to periodically varying forces that acted along the long axis of the subject's body and at right angles to this axis. It is believed that the varying forces directed along the body axis stimulate the vestibular organs and thus cause swing sickness. The susceptibility of the subject was measured in terms of the time he could endure the swinging before the first symptoms of airsickness developed. The objective symptoms employed as indices were pallor, sweating and vomiting and nausea was taken as a valid subjective symptom of approaching swing sickness.

In tests made on 254 air gunners, fifty (or 19.7 percent) were susceptible (7). Of these susceptible men, 37 showed symptoms before twenty minutes of swinging were completed while 13 were markedly affected at the end of twenty minutes. This percent incidence corresponds to the incidence of airsickness among trainees (17 percent) during the first few hours of flying. However, cadets adapt to airsickness after about six hours of flying so that actual pilot wastage in the Royal Air Force due to airsickness is between 0.85 and 1.59 percent (7). A similar adaptation to swing sickness occurs in many men. Therefore, subjects can be further classified according to their ability to adapt to swinging motions. A series of four tests spaced one to four days apart showed only 1.7 percent of the original 254 gunners unable to adapt to swinging. Further studies may show this failure to adapt to swing motion to be a measure of susceptibility to (recurring) airsickness. This study emphasizes that a single test on the swing is not sufficient to establish a man's ultimate susceptibility to airsickness.

Further studies have confirmed the correlation between susceptibility to airsickness and to swing sickness. Thus of fifteen R.A.F. men who were consistently airsick twelve were swing sick during a single test and of fifteen men who were never airsick only two were swing sick. Despite this correlation, the single test is not sufficiently discriminatory for selecting or rejecting personnel, because if these tests had been used as a basis of classification 13 percent of good pilots would have been rejected and 20 percent of the poor ones admitted (8).

The correlation between swing sickness and airsickness has been confirmed in other experiments at Randolph Field (9). In these studies the subjects were given a score as a measure of their susceptibility to swing sickness. A score of ten was given to a man if he showed no symptoms in twenty minutes. The scores of seven-eight-nine were reserved for those showing varying degrees of symptoms at the end of twenty minutes. The five-six rating were for those lasting less than twenty minutes and more than ten. For these men the test was ended either by complaint of nausea or by vomiting. The low scores, one to four, were reserved for those who lasted less than ten minutes, using the same criteria. The results obtained on 150 subjects showed 74.8 percent immune to swinging. About 11 percent had mild symptoms and 14 percent severe symptoms. Of the four subjects with a history of recurring airsickness three were severely swing sick and one mildly so.

By means of the individual scoring these results can be related to other scored properties of the individuals. The investigators conclude that at present the twenty-minute swing test will indicate about half of the men susceptible to airsickness with a false rejection of one-tenth of the nonsusceptibles. The adaptibility emphasized by English workers was not considered.

A second test for susceptibility to airsickness is based upon the fact that the labyrinthine mechanisms involved in maintaining equilibrium are concerned in producting motion sickness. When cold water is placed in the outer ear (unilateral) the receptors located in the semicircular canals are stimulated by the convection currents produced in the endolymph. The degree of excitation is estimated in terms of the time until nystagmus starts, the time it persists, or the ratio of these two times.

In twenty-four Royal Air Force subjects no relation was found between this caloric response and susceptibility to airsickness (10). Since the test causes the stimulation of the organs in the semicircular canals they are apparently excluded from involvement in airsickness. It is, therefore, the opinion of Hallpike and Fitzgerald (10) that one of the otolith organs is responsible for airsickness. In a further study (5) of personnel grounded because of airsickness abnormal caloric reactions were observed but there was no correlation with susceptibility to airsickness. However, in the same group a correlation was found between susceptibility to swing sickness and to airsickness.

There are conflicting reports relating to tests for susceptibility to airsickness. Thus a survey in the School of Aviation Medicine at Randolph Field (9) showed that individuals with a high susceptibility to airsickness had a history of motion sickness caused by swings and boats. However, in a Canadian survey of 1433 trainees (1) there was no correlation between previous history of seasickness and susceptibility to airsickness. These divergent results extend to other correlations. Thus English observers (5, 10, 11) find no correlation between airsickness and caloric tests of semicircular canals, but do find a correlation between airsickness and swing sickness (6, 7). Furthermore, there is a reported correlation between seasickness and the caloric test (12). Thus, one must conclude that swinging and flying stimulates a set of receptor organs different from that set stimulated by caloric tests or by motion of a boat. This result indicates a difference in the mechanisms producing the various forms of motion sickness. Individual susceptibility may, therefore, be a question of the sensitivity of a special organ and not general susceptibility to motion sickness. However, it is the impression of the investigators at the School of Aviation Medicine (9) that a correlation exists between susceptibility to airsickness and the cold caloric tests. These several points of difference should be intensively investigated to determine whether we are dealing with one problem of susceptibility to motion sickness or a set of separate problems determined by the kind of motion considered.

A third possible test for susceptibility to airsickness is suggested by results of animal investigations relating to the physiological mechanisms involved in this disease. It has been found that dogs can be given motion sickness by swinging them in a box (cats are refractory) (14). They have an individual susceptibility and can be classified

according to the same methods used in human classification. The symptoms are yawning, salivation, panting, nausea, apathy, and prostration. These symptoms could arise from generalized parasympathetic activity. That this is probably true is indicated by the corresponding effects of injecting acetylcholine or prostigmine. Indeed the susceptibility of dogs to swing sickness parallels their susceptibility to acetylcholine. Thus, one milligram of acetylcholine per kilogram produces sickness in the most susceptible dogs and refractory dogs tolerate as much as two milligrams per kilogram. Consequently, investigations are in progress to determine whether graded injections of acetylcholine can be used to assay human susceptibility to motion sickness (14).

This approach focuses attention on production of symptoms while the previously mentioned tests emphasize the importance of the pattern of receptor stimulation. In order for this pharmacological test to be valid, it would have to measure both aspects of susceptibility to motion sickness. Therefore, it would be of interest to know whether an individual, who has adapted to swinging, also loses his susceptibility to acetylcholine. The results of such an experiment might indicate a way to assess susceptibility to motion sickness by two scores. First, special sensitivity of receptor organs to stimulation by particular forms of motion and, second, special sensitivity of effector organs to the nervous excitation thus produced. Such a subdivision may straighten out some of the discrepancies reported above.

Several investigators have found that certain types of experimentation are not productive. Thus, effects of complicated moving visual patterns could not be related to incidence of airsickness (20). Range of motion of viscera in individuals was not related to incidence of seasickness (21).

It will be obvious from this review that none of the tests is ready to be used as a basis for selecting personnel immune to airsickness. Though classification can be made, using a single swing test, the factor of adaptation is not measured thereby. Further evaluation of the other classification methods is required in view of the discrepancies in existing reports.

The ultimate solution of this problem is made more difficult because of the strong psychic component in the disease. Thus, the effect of other people being sick is sufficient to precipitate an attack (15) and apprehension developed by susceptible individuals affects even their ground work (13). It has been suggested that persons who generally react to unusual circumstances by a feeling of nausea are potentially victims of airsickness. In this connection, there is a type of chronic airsickness that develops after men reach the operational stage (1). This is considered to be different from early airsickness and occurs in men with no previous history of airsickness. It may be a neurogenic form of the disease.

The cases of airsickness with which the medical officer must deal can be classified into three types. In the first group, are those who are sick during early training. This is usually due to apprehension,

and disappears after several hours in the air. One of the best forms of control of disease in this type is to discourage "stories" of airsickness and to explain the principles of adaptation to the airplane motions (26). There are a smaller number of persistently airsick men who should cease flying if no adaptation occurs after ten to twenty hours in the air (26). This chronic form of the disease is attributed to hypersensitivity of organs in the internal ear. In addition, there are cases which develop after a period of normal flying. In this group, several causes must be investigated, such as:

1. Any physical illness.
2. Change in plane type or position in the crew.
3. A neurosis arising from loss of keenness for flying.

Methods of prevention or cure are unknown, but certain aids to the management of the disease have been recommended. Among these are (26):

1. A high carbohydrate diet.
2. Avoidance of alcohol for twenty-four hours before flying.
3. Ingestion of glucose in the form of barley sugar before flying and while in the air.
4. A small dose of phenobarbital about one-half hour before flying.

It has also been suggested that the effects of vertical motion (bumping) can be minimized by bending the head forward whenever possible. During turns, furthermore, the stimulation of the organs in the internal ear will be reduced if the head is held fixed in relation to the aircraft (26).

There are certain other predisposing factors that can be controlled. Thus, factors contributing to airsickness among glider troops were (15):

1. Position and arrangement of seats.
2. Cold.
3. Degree of crowding.
4. Effect of others being sick.
5. Lack of fixed horizon.
6. Monotony.
7. Apprehension.

Recommendations for troop transportation have been prepared (16) which suggest attention to food, noise, and cold. The problem is especially serious among paratroops for they must be ready to fight as soon as they land. Prolonged training flights were recommended as a method of selecting paratroops, because the flights used in jumping practice were not long enough to evaluate a man's susceptibility to airsickness (18).

Airsickness thus affects the performance, not only of pilots and bomber crews, but is a serious problem in aerial transport of troops, in glider tactics, and in paratroop operations. Unfortunately, even the training which puts these troops into superb physical condition does not seem to reduce the incidence of airsickness (23). To select immune

personnel in such large numbers would be a tremendous task even if adequate tests were available. In many ways, therefore, some preventive or palliative medication might be a practical method of control of this malady. Despite extensive lists of proposed and tested remedies (2, 19, 24), no preventive has been reported. Prostigmine, atropine, benzedrine, and a capsule containing sodium phenobarbital, hyoscine hydrobromide, and benzedrine were all ineffective in preventing swing sickness. The non-proprietary remedies for seasickness and airsickness, with most reputation, are belladona alkaloids, benzedrine, and cerebral sedatives, particularly chloretone. (19) In this connection, it has been emphasized that the speed of recovery from airsickness is an important consideration (5). Consequently, any palliative medication would be useful.

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